

## §6. Water-Vapor Decomposition by Using Zirconium-Nickel Alloy

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A decomposition-processing vessel was developed for hydride compounds like methane and water vapor. The vessel can be installed in a tritium cleanup system for application to exhaust gases discharged from fusion facilities. The system is distinguished from conventional ones from the viewpoint that all tritium in various chemical forms in the exhaust gas is removed as tritiated hydrogen molecules. The developed decomposition-processing vessel can be used to make hydrogenated compounds decompose into their respective elements so as to extract the tritium only in the form of hydrogen molecules, and other elements are fixed within the vessel.

In my previous studies, to develop a decomposition-processing vessel for tritiated compounds, zirconium-nickel alloy was examined using methane, because methane is one of typical tritiated constituents in exhaust gas discharged from facilities for handling or producing (or both) tritium like a fusion experimental laboratory. In the present study, I used water vapor as a target constituent to be decomposed instead of methane, because water vapor is also another one of the main tritiated compounds. I carried out an experiment to examine how water-vapor was decomposed by zirconium-nickel alloy.

Performance tests were carried out using helium gas mixed with about 1.1% water vapor by using an in-house humidifier, in which water vapor was added to the helium carrier gas through the humidifier. The flow rate of the humidified helium gas was 35 standard  $\text{cm}^3/\text{min}$  and the gas temperature in the vessel was 873 K during the entire experiment. This decomposition condition is exactly the same as those assumed in the methane decomposition carried out in previous studies.

The present experiment is the first trial of water-vapor decomposition using zirconium-nickel alloy. I performed the experiment of water vapor decomposition on ZrNi alloy three times. For each measurement, concentrations of both water vapor and hydrogen, generated from water-vapor decomposition, were observed at the inlet and outlet of the decomposition-processing vessel by using a gas-chromatograph system. Consequently, I obtained exactly same results for three time measurements. Typical one of those measurements is shown in Fig. 1, in which the horizontal solid line indicates the initial concentration of water vapor (about 1.1%) before undergoing the decomposition process. The changes in the concentration of the flowing gas just after the decomposition process are plotted as a function of the elapsed time by open circles and open squares for water vapor and hydrogen, respectively. As

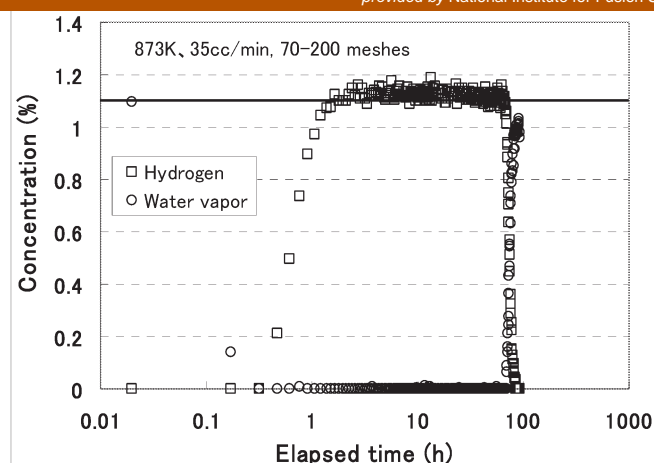


Fig.1 Change in water vapor and hydrogen concentrations in the flowing gas just after the decomposition process

shown in Fig. 1, the water-vapor concentration decreased immediately first. Hydrogen (which should be generated by the water-vapor decomposition) was not detected in this stage (0.3-0.5 hours elapsed time). The hydrogen peak was found first at an elapsed time of about 0.5 hours, after which the hydrogen concentration gradually increases. It must need a proper time delay for development of decomposing absorbed water vapor in ZrNi alloy.

After that, the increase in hydrogen concentration led to a full-scale decomposition reaction. The fastest decomposition of water vapor and generation of hydrogen were first observed at about one hour after the start of the process, and then a briskest reaction was maintained for about seventy hours. At the bottom of the curve for water vapor about 1.1% hydrogen was observed, but water vapor was not detected at all, which meant almost 100% of the water vapor was decomposed. After that, it subsequently weakened gradually, and approximately 85 hours later, the water-vapor decomposition ceased.

The experimental results show that zirconium-nickel alloy can easily decompose water vapor, in particular, hydrogen can be extracted in the form of hydrogen molecules under the same decomposition condition suitable for methane decomposition (temperature: 873 K; gas flow rate: 35 standard  $\text{cm}^3/\text{min}$ ; material size: 70-200 meshes).